rope was over 80 per cent; since that time the percentage has gradually fallen until it reached 72 per cent in 1902, and in 1905 was but 67.23 per cent of the total, while the share of the exports taken by those grand divisions to which the exports are chiefly manufactures shows an increased percentage in 1905 compared with 1904.

A NEW FRENCH COMPOUND LOCOMOTIVE.

BY FRANK C. PERKINS.

The powerful tank locomotive herewith illustrated has recently been constructed and placed in operation by the Compagnie du Chemin de Fer du Nord. It has two sets of six-coupled driving wheels, one set in front and the other at the rear, with two bogie wheels connected with each truck, one pair following the six forward drivers and the other pair on the rear truck leading the six rear drivers. Each set of eight wheels is carried in its own separate swiveling truck. There are two separate sets of tanks for water and fuel, one located over the forward driving wheels, and the other over the rear drivers and inclosed with a cab as noted in the illustration.

This locomotive is of considerable length, measuring 16.186 meters over all and including the bumpers. The total heighth of the locomotive is 4.22 meters and the total width 2.874 meters. The following interesting data as well as the drawing and photograph was furnished by G. Du Bousquet, l'ingenieur en chef du materiel et de la traction of the La Chapelle works of the Chemin de Fer du Nord.

This locomotive has a boiler with 130 tubes, each 4.75 meters in length and of an external diameter of 70 millimeters. The total heating surface of the boiler is 244.55 square meters, of which 234.56 square meters represents the heating surface of the tubes.

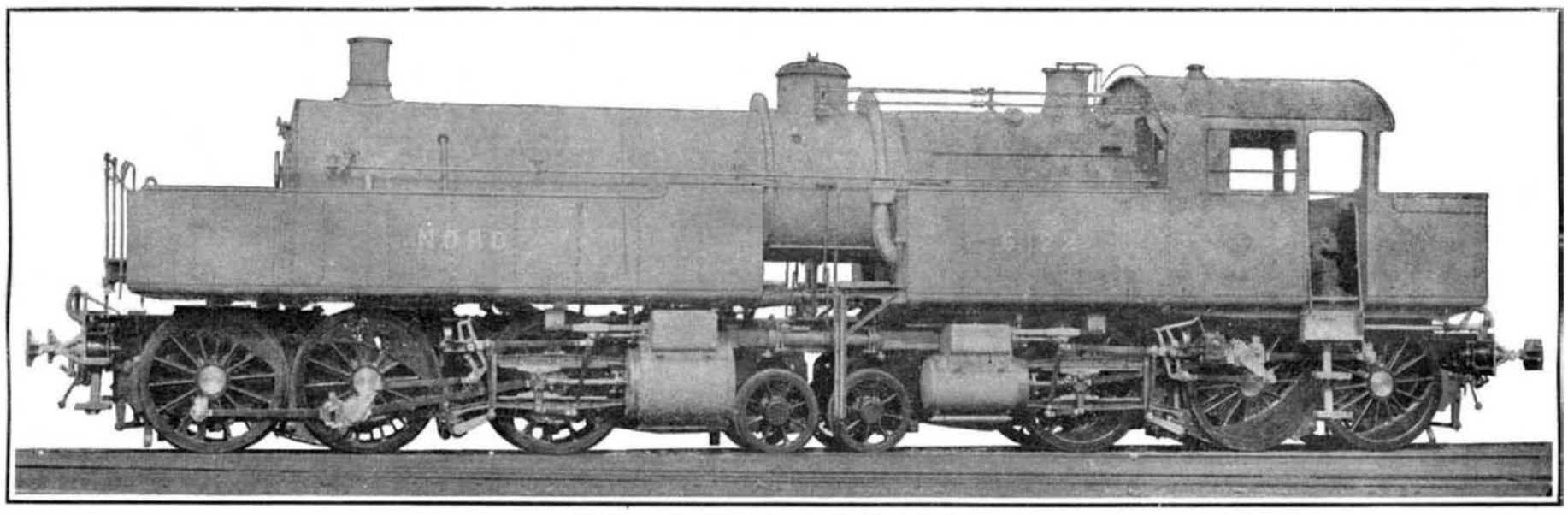
The grate is 2.54 meters in length and 1.186 meters in width, giving a total grate area of about 3 square meters. The steam pressure is said to be 16 kilogrammes per square centimeter for this boiler, with a maximum steam pressure of 6.5 kilogrammes per square centimeter for the low-pressure cylinders. The boiler shell has a diameter of 1.456 meters and is constructed of steel plate 17 millimeters in thickness. It is mounted 2.8 meters above the rail. The steel frames are more than 12 meters long and are spaced 1.142 meters apart.

The high-pressure cylinders are 400 millimeters in diameter and the low-pressure cylinders are 630 millimeters in diameter, the piston stroke in each case being 680 millimeters. The diameter of the six driving wheels is 1.455 meters, while 0.850 meter represents the diameter of the four bogie wheels. The total wheel base of each truck or the distance from the center of the bogie wheel axle to the last driving wheel axle is 5.795 meters, while the total wheel base of this tank engine is 12.59 meters.

The total weight of this French engine empty is 81.482 tons, while its weight complete with water and fuel ready for operation is 105.43 tons. The total adhesive weight of the locomotive complete is 88.93 tons and it has a maximum effort when working as a compound engine of 18,607 kilogrammes with an increased tractive effort of 24,064 kilogrammes with a direct admission of steam at high pressure in the large or low-pressure cylinders. The coal bunkers are capable of holding five tons of fuel, and the capacity of the water tank is 12.8 tons of water.

The method of carrying the steam from the boiler to the cylinders on the swiveling trucks and from the trucks back to the smoke box is as follows: The steam pipe runs from the steam dome down to a swivel joint arranged vertically over the king-pin of the truck with its axle in line with the king-pin. Thence it is led to the high-pressure cylinders, from which it passes to the low-pressure cylinders through a length of flexible coupling. The exhaust is led to the smoke box through a swivel joint in the center of the low-pressure cylinder truck.

Provision is made for supplying both the high-pressure cylinders and also the low-pressure cylinders with high-pressure steam when found necessary, in starting heavy loads or on heavy grades when increased power is found desirable. In this case the engine operates as a simple locomotive with four cylinders.



A NEW FRENCH MALLET COMPOUND LOCOMOTIVE.

Total heating surface, 2,361 square feet. Steam pressure, 228 pounds. Cylinders: High-pressure, 16 inches, low-pressure, 25 inches diameter, by 27 inches stroke. Weight, 105.4 tons.

Opening of Broadway Extension to Harlem River.

The final section of the new subway at the extreme north end of Manhattan Island to the south bank of the improved Harlem River or ship canal was completed and put into operation on March 12, with the exception of two deep underground stations located at 168th and 181st Streets. These are 100 and 125 feet below the surface at Washington Heights, and are connected by electric elevators in shafts sunk through solid rock; no stops will be made there until they are finished, which is promised at an early date. The shafts are 15 feet by 32 feet in size. The size of the stations cut in the rock are 320 feet long, by 73 feet wide at the shafts, but narrower at each side sufficient for platform space. Trains are now run from the Battery at the extreme south end of the island to the 157th Street station, there a transfer is made to the train running over the extension to Harlem River and King's Bridge every eleven minutes. When all the stations are completed it is expected trains will be run through without transfer. A person is now able to have quick transit from one end of the island to the other for the moderate fare of five cents, a certainty which but a very few years ago seemed like a visionary dream.

The first elevated structure of the Broadway section of the subway is in the neighborhood of West 125th Street, over what is known as Manhattan Valley. The road then runs underground under Broadway or King's Bridge Road to 169th Street thence north in a straight line under St. Nicholas Avenue and Washington Heights to 199th Street, where it emerges from the hill on to the second elevated structure, comprising three tracks over what is known as the Inwood Valley to 218th Street station located on the south bank of the Harlem River and opposite the south end of the drawbridge over the river at this point.

It is expected a new double-decked drawbridge will supplant the present one by which the road can be carried over the Harlem and the tracks of the New York Central and Hudson River Railroad now running along its northern bank, up under Broadway to Yonkers. It has taken five and a half years to complete this section.

A most charming and desirable residential section of the city will thus have convenient and frequent transit to all other business sections.

Rush Paper.

Very little paper has been made of late years from rags. Vegetable substances are employed, as alfa, wood, and straw; the idea has not prevailed that the wild or cultivated rush can be employed for this purpose. But an inventor has ascertained that, when suitably treated, the plant will produce a very white and consistent paper pulp by means of the following treatment: 1,000 kilogrammes of the green rush, cut up as fine as possible, is mingled with a caustic lye of 30 deg. B., and boiled in an autoclave for five or six hours under a pressure of 6 kilogrammes at 170 deg. C. The pulp is washed with water, sulphuric acid in suitable quantity added, then bleached with chloride of lime and washed energetically. It is then suitable for employment in the manufacture of paper.—Le Papier.

HOW SHINGLES ARE MADE.

BY DAY ALLEN WILLEY.

Although over $20,000,000 worth of shingles are manufactured in the United States yearly, this portion of the timber industry is perhaps least known of the several divisions into which the products of the forest enter, partly for the reason that the making of shingles, especially in the eastern part of the country, is usually carried on in connection with the ordinary sawmill. In fact, the making of shingles is classed as a part of the sawmill industry, but in the States which produce the greater proportion of the shingles, one finds very large plants devoted to shingle making entirely.

As everyone knows, hemlock, cypress, and white pine are used extensively for roofing purposes. Cedar, however, is employed to such an extent that over half of the shingles annually cut in the United States are of this wood, the output of white pine shingles representing about $3,500,000 in value and the cypress $3,000,000, nearly all of the remainder being contributed by hemlock, which is used widely in the East. As cedar forms such a large proportion of the forest growth of Oregon and Washington, we find in these States the majority of the mills devoted entirely to making shingles. They secure the raw material usually in the form of "bolts"—logs which have been cut to the exact length of the shingles desired, so that it is only necessary to split the bolt into the requisite thicknesses and finish the sections for commercial purposes. As a rule, the mills are located in the vicinity of woodland which has been stripped of the first growth.

As is well known, the custom prevails in the Northwest in cutting large trees of making the necessary incision anywhere from 6 feet to 10 feet above the ground, as the felling can be done with more safety and less difficulty. Consequently, a single stump of a tree 5 feet or 6 feet in diameter will cut into a surprisingly large number of shingles if it is sound in the heart. The bolts are made with cross-cut saws operated by hand, or portable saws driven by engines mounted on trucks belted to mechanism especially designed for this class of work. As the lengths into which the stumps or trunks are cut make them of a size which can be readily handled, the use of a tramway or skidway is unnecessary, and frequently advantage is taken of some watercourse to construct a flume of suitable dimensions. This consists merely of a conduit of planks supported at various distances from the surface according to the grades to be overcome. The water may be secured from a spring or creek on the hillside, although at times it is diverted from a larger stream by damming the latter, the fall of water in the flume being sufficient to carry the bolts to the mill.

Some of the flumes in Washington are ten and twelve miles in length. As fast as the timber is removed they are extended through the tracts where the bolt cutters are operating, since it is only necessary to place the bolts in the flume and thus transport them directly to the mill pond. The cost of building the flume is so small, that this novel method of transportation is generally the most economical by far. But a small amount of water is required, as the cedar is so light that it will float in a very shallow depth. At the mill end of the conduit it enters a pond, where it is kept in a boom like the ordinary sawlogs until required.

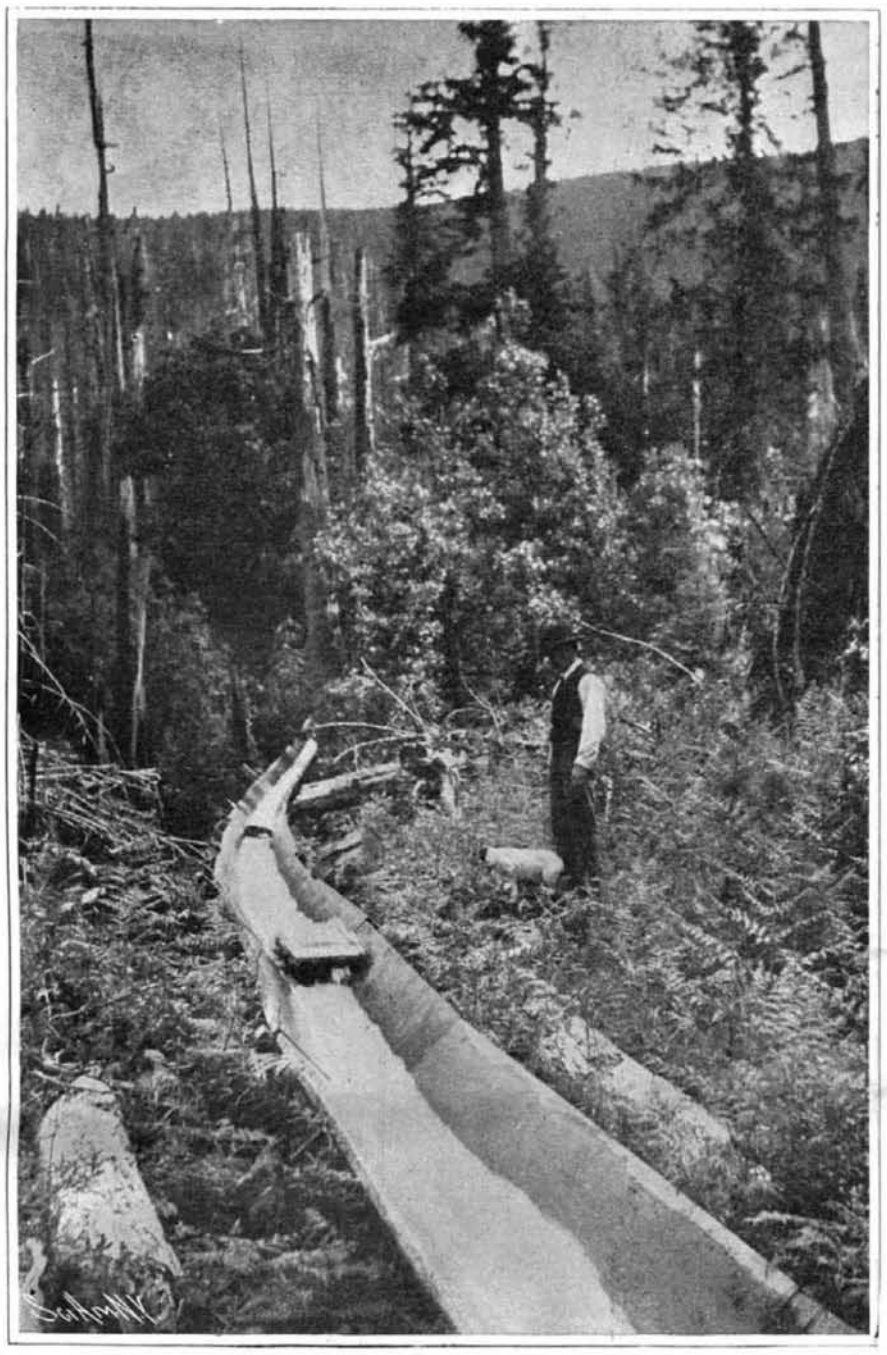
The shingle mill, like the sawmill, is provided with an inclined way leading into the water. This is fitted with an endless conveyer, upon which the bolts are guided by the "bolt puncher," as he is termed. Leaving the conveyer, they are taken by hand or by another conveyer to the cutting machinery, and there reduced

to shingles. In the shingle mill itself this mechanism is of two kinds. In one the bolt is sawed, while in the other the bolt is riven by means of a special cutter. Some of the larger shingle-riving machines are provided with a series of knives which will split up ten bolts at once. They are nearly circular in form, and are fed by hand from the top. Before the bolt is placed in the flume, as already stated, it is sawed to the proper length, just as logs are usually cut before leaving the woods, so that it is only necessary to run them through the band saw or circular saw to turn them into beams, planking, or other forms desired. The bolts from the larger trees are split to a size which will allow them to be placed in the bolt cutter before being taken to the mill, so that the shingle-making machinery can be operated continually if desired.

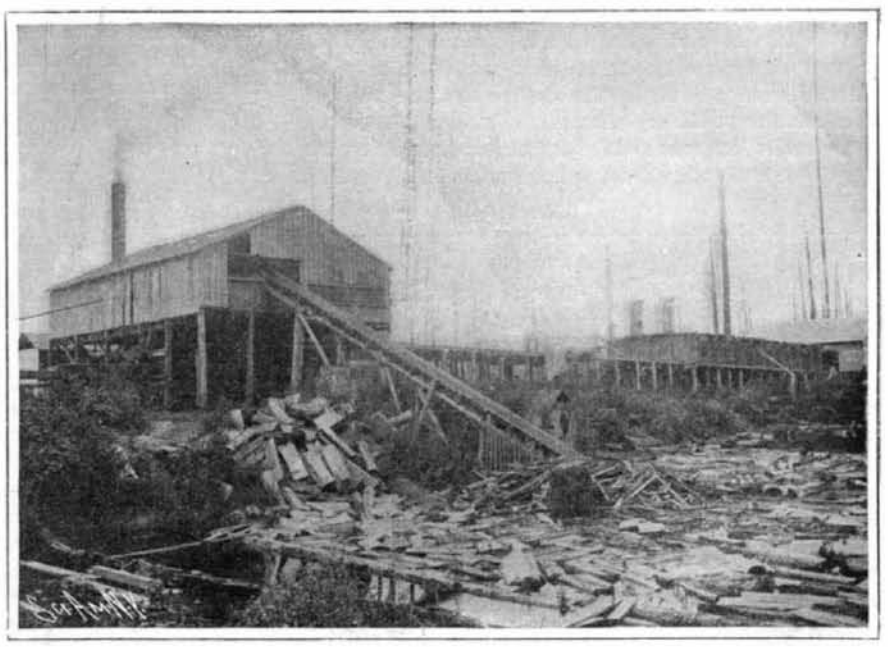
The standard size shingle used in the United States is 6 inches in width by about 18 inches in length. Consequently, the majority of the riving machines are designed to turn out shingles of these dimensions, but in addition a shingle jointer, as it is termed, is frequently used to trim off the rough edges when it is necessary to perform this work.

The most important centers of the shingle industry of America are the towns of Ballard, on Puget Sound, and Vancouver, on the lower Columbia River, as each is located adjacent to an enormous supply of raw material. At Tacoma as well as Seattle large mills are also in operation, devoted to the production of this form of lumber, working on cedar almost entirely. A better idea of the magnitude of this industry in the State of Washington can be gained, when it is known that the State produces fully forty per cent of the material manufactured in the United States. Frequently entire shiploads of cedar shingles are exported from Puget Sound, owing to the very extensive foreign demand, not only for roofing, but for other purposes.

The shingle industry is of great importance from the standpoint of forestry, as it has prevented the loss of a very large quantity of valuable timber. It is calculated that actually less than one-half of the timber value of the average tree in Washington and Oregon is converted into planking and commercial lumber, owing to the wasteful methods which are employed in felling the forest. The development of the shingle industry has utilized much of the material which would otherwise decay, but the area which has been stripped of first-growth trees is so extensive, that twice the present number of shingle mills could be located in this section of the Northwest, and find ample material for their needs. In addition to the stumps, however, small trunks are also cut into bolts, where the diameter of the tree is of a size which will allow it to be split without too much waste. Therefore considerable timber which is considered too small for planking and logs is utilized for shingles.



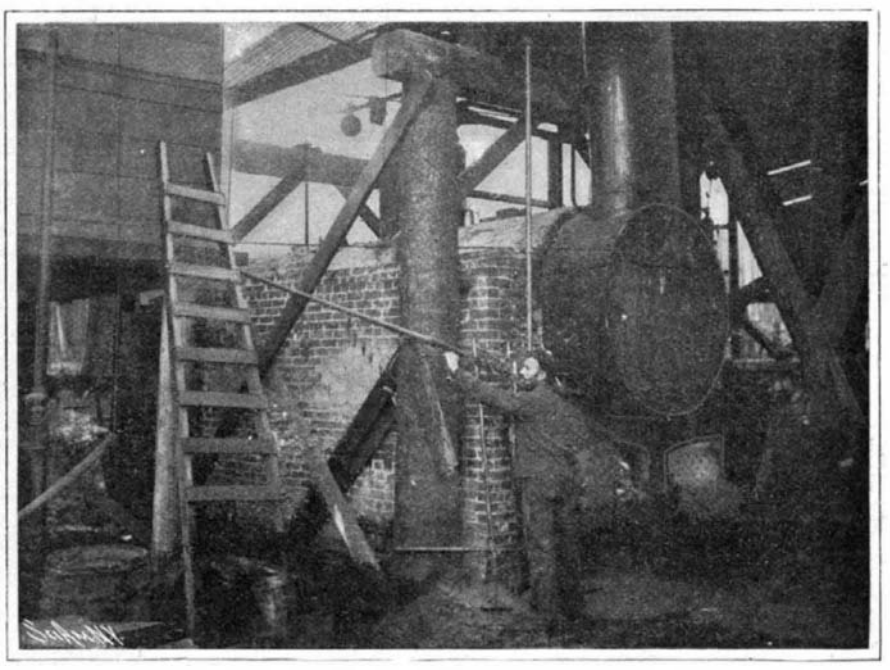
Shooting Bolts Down a Flume to the Mill.



Shingle Mill and Pond.

Hauling Out Logs to be Cut into Shingle Lengths.

A Shingle Cutter Which Works on Ten Bolts at Once.



Shingle-Mill Boiler Fired Entirely with Sawdust from the Bolt Cutters.

HOW SHINGLES ARE MADE.

The Canadian Pacific Railroad Company has obtained authorization from the Dominion government to build another line through to Georgian Bay from Peterboro. This will give the company another terminal on the upper Canadian lakes.